

## Modeling Football Penalty Shootouts: How Improving Individual Performance Affects Team Performance and the Fairness of the ABAB Sequence

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**Abstract :** Penalty shootouts often decide the outcome of important soccer matches. Although usually referred to as “lotteries”, there is evidence that some national teams and clubs consistently perform better than others. The outcomes are therefore not explained just by mere luck, and therefore there are ways to improve the average performance of players, naturally at the expense of some sort of effort. In this article we study the payoff of player performance improvements in terms of the performance of the team as a whole. To do so we develop an analytical model with static individual performances, as well as Monte Carlo models that take into account the known influence of partial score and round number on individual performances. We find that within a range of usual values, the team performance improves above 70% faster than individual performances do. Using these models, we also estimate that the new ABBA penalty shootout ordering under test reduces almost all the known bias in favor of the first-shooting team under the current ABAB system.

**Keywords :** football, penalty shootouts, Montecarlo simulation, ABBA

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